Comparison of the in-stream fauna and resources of Tasmanian river reaches lined with willows or with other riparian types.

by

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The widespread distribution of willow trees (*Salix fragilis*) has been thought to impact deleteriously on in-stream faunas in south-eastern Australian rivers. This thesis aimed to address some of the speculation in the literature regarding the impacts of willows through three main research areas. Firstly, a survey was used to compare riparian function of willow vegetation to native riparian vegetation and associated impacts on macroinvertebrate populations. Secondly, the same approach was used to examine differences in macroinvertebrate and fish populations between willowed vegetation and reaches where willows has been removed. Finally, the role of willow large woody debris (LWD) in Tasmanian rivers was investigated. This involved a census of large woody debris standing stocks in 142 reaches on Tasmanian rivers. The ecological role of willow LWD was investigated via a comparison of in-stream native wood to willow wood and the associated effects on macroinvertebrate and fish populations. In this thesis, large woody debris (LWD) refers to large organic woody material defined conventionally as greater than 1.0 m in length and 0.1 m in diameter (Gippel, 1995).

The principal effects of willow vegetation on the biota occurred in summer and were due to a combination of shading effects and decreased water quality and alterations to channel morphology in willowed reaches. While reaches in native riparian zones supported higher densities and numbers of taxa, these were significantly lower in willowed reaches. A slight effect was observed in autumn as macroinvertebrate diversity in willowed reaches was lower than native reaches. I concluded that willows act as a poor surrogate for native riparian vegetation.

Comparisons between willowed reaches and reaches where willows had been removed revealed major differences in resources derived from riparian vegetation. Willowed reaches had high organic matter standing stocks and usually low epilithic growth on the substrate. In contrast, removal reaches had lower organic matter standing stocks and higher epilithic biomass. The macroinvertebrate populations reflected these differences. Although no

differences were observed in summary variables such as density or taxon number, differences were found between functional feeding groups. Groupings generally reflected the food sources available in either a vegetated reach with a high organic input and a dense canopy or a non-vegetated reach with no canopy, higher incidental sunlight and therefore a denser epilithic cover. A separate study revealed that in extreme situations willowed reaches are severely impacted with a large decline in water quality and high organic standing stocks eliminating most intolerant taxa. Fish populations at these sites were also depauperate, while at remaining sites fish species showed a strong relationship with their preferred habitat.

Census estimates of woody debris revealed that rainforest vegetation has the highest standing stock of LWD across a spectrum of riparian types. Usually removal of woody native vegetation often in concert with active removal of in-stream LWD accounts for lower wood loadings in the Tasmanian rivers surveyed. Willow LWD is not common in rivers in Tasmania and is a poor ecological substitute for the more complex native debris, which supported higher densities and richness of macroinvertebrate taxa than willow wood; however, both wood types supported similar community composition. LWD provided important habitat for the fish populations surveyed and reduced or negligible standing stocks of LWD corresponded to a reduction in the number and size of particular fish species.

The findings confirm some of the speculations regarding the impact of willows on rivers in south-eastern Australia. Willows were found to be a poor surrogate for native vegetation although they provided important riparian resources in the absence of any vegetation at all. The restoration of riparian zones and selective and strategic removal of willowed vegetation over the long term and replacement with endemic vegetation should minimise the ecological impacts of riparian vegetation removal on macroinvertebrates and fish.

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1. General Introduction

Riparian vegetation is recognised as having a key influence on in-stream biological function through shading and inputs of litter (Cummins, 1993), and the relationship between different types of riparian vegetation and the impacts of human disturbance on riparian vegetation has been well documented (Hawkins et al., 1982; Dudgeon, 1989; Quinn *et al.*, 1992b; Townsend *et al.*, 1997). By contrast, far less is known about riparian-stream linkages in Australian lotic systems (Bunn, 1994). In particular, the in-stream impacts of a number of invasive exotic riparian species in rivers have been the subject of much speculation but remain poorly documented with any empirical data, and this situation is exemplified by the widespread introduction of willows (*Salix* spp.) in many temperate lowland rivers in Australia.

Willows were first introduced to Australasia in the 19th century and are now the dominant riparian tree in many lowland rivers in south-eastern Australia (Mitchell & Frankenberg, 1993; Cremer *et al.*, 1995) and New Zealand (Collier, 1993; Glova & Sagar, 1994; Lester *et al.*, 1994a). Their expansion along rivers is contentious, with willows being promoted for their value in bank stabilisation and "soft" river engineering works by some (e.g. Strom, 1962; Nanninga *et al.*, 1994)) or reviled by others because of the hydraulic problems they sometimes cause and their putative impacts on in-stream fauna (e.g. Standing Consultative Committee on river improvement, 1983; Frankenberg, 1995; Ladson *et al.*, 1997). Despite the controversy, there have been very few formal investigations of their in-stream ecological impact (Schulze & Walker, 1997), while the few investigations that have taken place have generally been inconsistent in their findings (Latta, 1974; Besley, 1992; Glova &Sagar, 1994; Lester *et al.*, 1994a). This is probably due to site specificity, with all of the published studies being restricted to a few (generally <3) sites, which are usually located in the same river system. This narrow empirical base prompted this study, where I sought to find general patterns across a variety of small to medium-sized rivers in Tasmania.